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# DYNAMIC ASSESSMENT OF AAC VERB SYMBOLS FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

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**BY**

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## DEDICATION

This project is dedicated to my nephew, Fabian Prieto Jr., who reminds me to stay curious. Thank you to my thesis advisor, who patiently guided me through this process, and the committee, who dedicated their time to participate in this project.

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## ABSTRACT

This study used dynamic assessment (DA) with graduated prompting to evaluate whether preschool-aged children with autism spectrum disorder (ASD) demonstrated learning potential with verb-based augmentative alternative communication (AAC) symbols. Four participants completed DA sessions across three instructional conditions: (a) requesting actions embedded in play, (b) labeling actions embedded in play, and (c) labeling actions presented via video. Performance across these conditions along with a control condition was compared using an adapted multielement single-case design. Three participants demonstrated learning in at least two instructional conditions, and only one showed progress in the control condition. Overall, participants initially required less cueing to use verb symbols to request actions than to label actions. Although there were initial advantages of the requesting condition, all but one participant showed progress in learning to label verbs with fewer supports. Across participants, there were minor differences between labeling conditions. Findings have implications for the design of AAC assessments and interventions involving AAC verb symbols.

*Keywords*: augmentative and alternative communication, autism spectrum disorder, verbs, dynamic assessment, pragmatic functions, embedded instruction, discrete trial training

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# Dynamic Assessment of AAC Verb Symbols for Children with ASD

Autism spectrum disorder (ASD) is a neurodevelopmental disability distinguished by difficulties with social communication and the presence of repetitive or restrictive behaviors (American Psychiatric Association, 2022). Approximately 30% of children with ASD have limited spoken language abilities (Anderson et al., 2007; Tager-Flusberg & Kasari, 2013). Children with ASD with complex communication needs can benefit from using alternative augmentative communication (AAC) systems to facilitate expressive language (Lorah et al., 2015; Muharib & Alzrayer, 2018).

In recent years, high-tech AAC options such as dedicated speech-generating devices (SGDs) and mobile technology devices (e.g., iPads) with AAC applications have become more popular for children with ASD (Lorah et al., 2015; Muharib & Alzrayer, 2018). SGDs or AAC applications designed for pre-literate children often use grid-based formats to present a screen display of symbols (e.g., graphic pictures, photographs) representing vocabulary items. A child selects a picture symbol to produce speech output, which serves a communicative function, such as requesting, labeling, commenting, or responding to questions. Learning to use these varied communicative functions, as well as vocabulary across different parts of speech, is essential for social interactions and future language development.

As a child's language develops, early words typically include nouns, action verbs, descriptors, and social words used for different pragmatic purposes (Brown, 1973; Laubscher & Light, 2020). However, in high-tech AAC application research including children with ASD, most peer-reviewed studies focus on teaching the use of noun symbols to request preferred items (Lorah et al., 2015; Muharib & Alzrayer, 2018). For children who need AAC,

there is a danger in limiting exposure to a wide variety of developmentally appropriate vocabulary required for early social interactions. Vocabulary options that are limited from various parts of speech may delay the progression from first words to word combinations and more advanced syntactic structures (Laubscher & Light, 2020; Binger et al., 2020). Access to functional and developmentally appropriate vocabulary via AAC is needed to create a rich initial lexicon to support subsequent growth (Beukelman & Light, 2020). Therefore, it is critical for AAC research to explore whether children with ASD can learn to use parts of speech beyond nouns. As action words are typically part of a beginning communicator's early lexicon, verb learning is one area that should be explored further (Laubscher & Light, 2020).

**Verb Use Among Children with ASD Who Do Not Rely on AAC**

Research has supported the fact that children with ASD who do not rely on AAC use verbs in their everyday speech (Douglas, 2012; Haebig et al., 2020; Jiménez et al., 2020). However, the types of verbs produced can be impacted by the social communication challenges associated with ASD (Douglas, 2012; Jiménez et al., 2020). For instance, young children with ASD who use natural speech may be more likely to use action verbs (i.e., those that concretely describe the movement or change performed by another person) than other verb categories such as those related to a change to an internal state (Douglas, 2012). Additionally, although children with ASD may use a high proportion of verbs, they may be less likely to use social verbs (Haebig et al., 2020; Jiménez et al., 2020). Haebig et al. (2020), reported that the four most common verbs used by participants with ASD included *go, stop, eat,* and *tickle.* The authors noted that although *tickle* is a social word, it also has a sensory component that might motivate children with ASD.

Although descriptive research suggests that many children with ASD develop the use of action verbs, intervention studies have also been designed to increase verb use among children with ASD and natural speech abilities. Such studies often present action verbs using either video stimuli or in vivo (live) models in which an adult or toy figurines engage in targeted actions that participants are asked to label (Frampton et al., 2016; Schulman & Guberman, 2007; Shepley et al., 2016). Intervention methods used in these studies have included syntactic clues, time delay, questions, verbal models, reinforcement, and matrix training. Although studies using video-based stimuli have had positive outcomes, whether results would generalize to more natural settings or not is unclear (Schulman et al., 2007; Shepley et al., 2016). Additionally, although Frampton et al. (2016) used in vivo models involving toy figurines to successfully teach children with ASD to use agent-action labels, the toy-based models were presented under highly structured contexts.

**AAC Verb Interventions**

Although there have been positive outcomes for highly structured verb learning studies involving children with ASD who do not rely on AAC, there are additional challenges to teaching verb use with AAC devices. For example, although nouns representing tangible objects are more easily depicted statically in aided AAC systems, action verbs may be harder to represent as their meaning comes from the movement of the object/person (Schlosser et al., 2019). Research also suggests that typically developing adults can judge the meaning of noun symbols more quickly than verb and adverb symbols (Shin et al., 2017).

Despite the challenges of representing verb symbols statically, AAC research involving non-autistic populations (e.g., those with speech sound disorders) suggests that verb symbols can be taught to children with complex communication needs (Binger et al.,

2008, 2017a; Tönsing et al., 2016). Such studies have used strategies such as aided language modeling, (Binger et al., 2008; Binger et al., 2017a) and prompt hierarchies (Tönsing et al., 2016) to teach children to label different stimuli with aided symbol combinations involving verbs (e.g., agent-action). Although these studies used everyday routines such as storybook reading and play to teach verb use, findings from Binger et al. (2017a) suggest that, for some children, stimuli may need to be adjusted to incorporate more structured tasks (e.g., watching video models depicting agent action sequences) to meet a child's motivational preferences or behavioral needs. It is unclear, however, whether findings from these studies would generalize to children with ASD.

Several recent intervention studies involving children with ASD have included AAC verb symbol targets (Carnett et al., 2019; Gevarter et al., 2021, 2022; Holyfield, 2021; Marya et al., 2021). Across studies, findings demonstrate that although children with ASD can learn to use verb symbols, for some individuals, progress may be gradual and procedural modifications may be needed. However, it is important to note that existing studies have used varied instructional approaches and targeted different pragmatic functions. For instance, three studies used behavioral strategies such as time delay, prompting, task analysis, and reinforcement to teach children to use one symbol verb responses to request, label, or fill in cloze sentences (Carnett et al., 2019; Gevarter et al., 2021; Holyfield, 2021). These studies also utilized embedded instruction, incorporating structured learning opportunities (trials) within naturally occurring contexts, such as play or storybook reading (Geiger et al., 2012). Preferred interests and items are typically incorporated into embedded instruction, and responses are reinforced with naturalistic consequences (Gevarter et al., 2021). For example, Carnett et al. (2019) taught children with ASD to use an AAC application to request actions

(i.e., UNLOCK, WATCH) needed to engage with preferred activities such as watching videos on an iPad.

Although one participant showed consistent independent responding with targeted actions, the other two participants required procedural modifications (ex: errorless learning trials). Similarly, Gevarter et al. (2021) reported mixed findings when using preferred activities to teach three preschool-aged children with ASD to use various symbols on an AAC application. In this study, parents were trained to embed opportunities for their children to request and reject objects. Such as, requesting an action; and labeling an action or making a social comment during natural routines (e.g., play, mealtime). Two of the three participants met mastery criteria across all targets but demonstrated more gradual acquisition of non-noun targets. The third participant only mastered targets involving nouns. More gradual success in acquiring non-noun targets was also demonstrated in a study in which participants were taught to fill-in in cloze statements presented in adapted books with either noun or verb symbols (Holyfield, 2021). Interestingly, in this study, some participants were more successful in using text-only AAC symbols compared to picture symbols paired with text for verb targets. The fact that this difference was not observed for noun-symbol targets supports the notion that static picture-based verb symbols may not be immediately transparent for children with ASD (Schlosser et al., 2019).

Two additional studies have focused on teaching children with ASD to use multi-symbol utterances involving verb symbols (i.e., agent-action responses) to label stimuli (Gevarter et al., 2022; Mayra et al. 2021). Although both studies used matrix training and prompting, one study embedded the presentation of stimuli in play (Gevarter et al., 2022) and the other presented video stimuli during structured discrete trial training (DTT) sessions

(Marya et al., 2021). During DTT, a clinician presents a specific stimulus to promote a target behavior that is reinforced (e.g., with positive verbal feedback or preferred tangible items). The instructional materials are not typically selected based upon participant interest and are not incorporated into a natural learning activity (Geiger et al., 2012). Although the DTT study involving video stimuli had more consistent positive results compared to the findings of the embedded play intervention (in which participants showed more gradual or varied progress with agent-action targets), participants in the Marya et al. (2021) study were required to master the use of noun and verb symbols in isolation prior to intervention. Similar to prior studies, findings from Gevarter et al. (2022) also supported the idea that children with ASD may acquire noun-based targets more rapidly than verb targets as participants demonstrated more immediate success with possessor-possession targets than agent-action targets.

**Factors That May Impact AAC Verb Intervention**

A particular set of methods that would benefit all children with ASD remains unknown, given that AAC research involving verb learning suggests mixed outcomes. One important consideration for the design of interventions for children with ASD is the selection of targets based upon pragmatic function. Several studies provide evidence that children with ASD show differences in their use of imperative and declarative communicative functions (Harbison et al., 2017; Jones et al., 2008; La Valle et al., 2020). Imperative functions involve making requests, and declarative functions focus on commenting, sharing information, or directing another person's attention (Harbison et al., 2017). Although requesting focuses on the natural motivation for desired actions or items (which may include the specific interests of a child with ASD), declarative functions rely upon social reinforcement. Imperative functions can also require more social-cognitive understanding and the ability to recognize

the internal state of others (La Valle et al., 2020). Jones et al. (2008) found that although young children with ASD did not differ from typically developing peers in their use of requesting, they did use significantly fewer comments. Other studies suggest that challenges with declarative functions may be even more pronounced for children with ASD and limited spoken language skills. For instance, a meta-analysis of 23 studies comparing declarative and imperative intentional communication acts (ICA's) across children with ASD has supported a relationship between declarative ICA's acts and language skills (Harbison et al., 2017). Another study found that children with ASD and minimal spoken language skills used imperative functions such as requesting and rejecting significantly more than vocally fluent peers with ASD and used commenting significantly less than vocally fluent peers (La Valle et al., 2020). The authors suggested that children with limited spoken language may experience difficulties with commenting due to deficits in joint attention. Joint attention abilities (which include a variety of nonverbal skills that allow an individual to communicate about an object or an activity with another person) are often delayed in young children with ASD who are pre-symbolic communicators (Bruinsma et al., 2004). The above findings may suggest that young children with ASD who have limited spoken language skills may benefit from interventions that make use of imperative functions (e.g., including opportunities to request motivating or preferred actions) when initially introducing new vocabulary targets.

Although the pragmatic functions targeted may influence motivation to communicate, instructional methods can also impact success with learning new language concepts. Embedded instruction and DTT are two evidence-based instructional approaches for individuals with ASD (Wong et al., 2015). Although direct comparisons of these instructional methods are limited, at least two studies have compared embedded instruction and DTT for

teaching receptive language and other early learning skills to children with ASD (Geiger et al, 2012; Sigafoos et al., 2006). Even though participants in both studies showed success with DTT and embedded approaches, advantages of embedded instruction included mastery of targets in fewer sessions, more correct responses, less self-injury and higher mood ratings**.** These potential advantages may be related to the fact that embedded instruction approaches incorporate a child's preferred activities/items as target stimuli to increase motivation. However, in some cases, embedded approaches can involve environmental distractions that make it harder to attend to stimuli/targets. In contrast, the structured nature of DTT may limit distractions (Geiger et al., 2012).

Although embedded instruction typically involves in vivo modeling of actions and skills, DTT for verb targets often involves video-based models. Some studies have reported efficiency benefits of using video-based stimuli in comparison to in vivo modeling to teach various skills to children with ASD (Charlop-Christy et al., 2000; Plavnick et al., 2016). In contrast, Wilson et al. (2013) found that children with ASD might show individualized differences in their success with in vivo versus video modeling. The study did find, however, that participants showed greater visual attention to video models. Another study involving three preschool-aged children with communication delays compared video and picture stimuli for teaching action labeling (Schebell et al., 2018). Results indicated that all children acquired target actions using the picture and video stimuli and generalized some targets to in vivo stimuli without direct instruction. However, the authors noted that learning history might affect the selection of stimuli most appropriate for a given individual.

**Dynamic Assessment and AAC**

Given the wide array of instructional components that might influence the acquisition of AAC targets, clinicians may benefit from utilizing assessment approaches that allow them to determine the individualized needs of children with ASD. One such approach is dynamic assessment. Using the principles of Vygotsky's social interactionist theory, dynamic assessment (DA) can determine communication targets within the child's zone of proximal development (Minick, 1987). When a graduated prompting dynamic assessment is used, a child receives varying levels of assistance (e.g., prompts, models), and an examiner keeps track of levels of support needed for successful responses across targets (Bain & Olswang, 1995; Patterson et al., 2013). A handful of studies have used DA with AAC (e.g., Barton-Hulsey et al., 2017; Binger et al., 2017b; Gevarter et al., 2020; King et al., 2015). Although not focused on children with ASD, Binger et al. (2017a) and King et al. (2015) used DA to examine the expressive syntax of children with communication disorders ages 3-5 who use AAC. Findings indicated that a child's ability to learn targets during DA with cueing support can predict a child's ability to learn the skill during the intervention.

A recent DA study involving six preschool-aged children with ASD examined the average levels of support participants needed to make AAC responses that varied in terms of parts of speech/communicative function and display complexity (Gevarter et al., 2020). Three participants with mild-moderate symptoms of ASD and prior experience with the Picture Exchange Communication System (PECS) demonstrated high levels or proficiency with one-step item requests involving noun symbols and decreased the supports they needed to use non-noun symbols (including verbs such as OPEN and CLOSE) to request or comment. Although three participants with severe symptoms of ASD and no prior experience

with PECS required fewer overall support with noun-based requests than other parts of speech/functions, they required high support across all targets (Gevarter et al., 2020). Although the design of the study did not permit conclusions regarding the relationships between participant characteristics, DA results, and intervention success, the three participants who showed progress during DA demonstrated success with similar targets in the Gevarter et al. (2021) intervention study. DA was not, however, conducted to determine the appropriateness of the agent-action comment targets introduced in the Gevarter et al. (2022) study. Given the mixed findings of that study, the use of DA may have better-informed intervention planning. For instance, DA could have been used to determine whether participants would show more learning potential with AAC symbol combinations used to request rather than label stimuli during embedded instruction. DA could also have explored whether video based DTT methods similar to those used by Marya et al. (2021) would lead to greater success with labeling than an embedded instructional approach.

**Purpose of the Study**

This study used DA to explore the learning potential of young children with ASD for acquiring AAC-based verb symbol use across different conditions. Similar to Gevarter et al. (2020), this study did not introduce a full intervention package aimed at teaching children with ASD to use AAC targets independently. Instead, repeated DA sessions were used to evaluate whether children were able to reduce supports needed to use verb targets in different conditions across a limited number of opportunities. Specifically, the study aimed to explore whether young children with ASD: (a) demonstrate progress in learning to use AAC verb symbols for different communicative purposes across varied instructional contexts and in comparison to a control condition; (b) differ in their ability to use verb symbols for different

pragmatic purposes (requesting vs. labeling); and (c) differ in their ability to use verb symbols to label actions across different instructional contexts (e.g., play-based embedded instruction vs DTT with video stimuli). The researchers hypothesized that children would demonstrate progress with learning verb symbols, but results across conditions would reveal individualized differences. For example, the researchers predicted that some children would require less support to use verb symbols for requesting than for labeling.

## Methods

### Participants and Setting

Participants in this study included four children who met the following criteria: (a) had an independent diagnosis of ASD (b) were between the ages of 3 and 6, (c) had limited use of spoken language (fewer than 50 functional words) as reported by clinicians or parents during formal interviews (see assessment and screening measures), (d) had prior experience with symbolic communication systems such as PECS, sign, or vocal speech (as reported by clinicians) but no prior experience using AAC applications, and (e) performed simple object requests following models or gestural prompts on an AAC application. The parent or legal guardian of each participant provided consent on a document approved by a university review board. The consent form described methods to determine their child's assent, such as approaching objects or engaging in activities. We recruited participants from local agencies serving children with ASD. Five participants (Charlie, Elijah, Nate, Pedro, and Sean; all pseudonyms) initially participated in screening assessments. Charlie was excluded from the study when he was unable to demonstrate the ability to follow model or gesture prompts to make object requests on an AAC application. The other four participants met study criteria

and went on to complete the dynamic assessment. Participants' characteristics (e.g., age, race/ethnicity, prior language use) are displayed in Table 1.

**Table 1**

*Participant Characteristics and Assessment Data*

| Participant | Age | Race or Ethnicity | Prior forms of communication | CARS-2[a] score and severity level | VABS[b] receptive language A.E.[c] | VABS receptive language A.E. |
|---|---|---|---|---|---|---|
| Elijah | *3.9* | White | ~5 spoken words; 2 manual signs | 34 Mild to moderate | *2:1* | *2:2* |
| Sean | *4.1* | Hispanic and Black | PECS III: 2-3 pictures per page; 2 manual signs | 36 Mild to moderate | *1:5* | *1:0* |
| Nate | *6.2* | White | PECS III: 6 pictures per page; 2 manual signs | 40.5 Severe | *1:2* | *1:0* |
| Pedro | *5.4* | Hispanic | ~20 spoken words; 2 manual sign*s* | *35* Mild to moderate | *1:4* | *1:8* |

[a] CARS-2 = Childhood Autism Rating Scale, 2nd ed. [b] VABS = Vineland Adaptive Behavior Scales. [c] A.E. = age equivalents

Table 1 also includes estimates of ASD severity, as measured by the Childhood Autism Rating Scale Second Edition; (CARS-2; Schopler et al., 2010) and expressive and receptive language skills, as measured by the third edition of the Vineland Adaptive Behavior Scales (VABS; Sparrow et al., 2016). These assessments are described further under Assessment and Screening Measures. Nate and Sean had prior experience with PECS but did not use vocal speech. Elijah and Pedro had minimal use of spoken language and no prior PECS experience. All participants were reported to use approximately two manual signs.

Elijah, Pedro and sign demonstrated mild-to-moderate to moderate symptoms of ASD, and Nate had severe symptoms of ASD. All assessment sessions took place either in private lab or clinic spaces at university speech and hearing sciences clinic (Nate and Pedro), or at a local applied behavior analysis clinic serving children with ASD (Elijah and Sean).

**Research Design**

The study compared three teaching conditions and a control condition for introducing AAC verb-based symbols using an adapted multi-element design (Gevarter et al., 2020). This design demonstrates experimental control in a manner similar to an adapted alternating treatments design (Schlosser, 1999; Sindelar et al., 1985). Conditions are rotated and assigned different targets, but a single-phase multielement design does not require a baseline. The differences between conditions establish control within each participant's data set (Cooper et al., 2019). Given that the study's overall purpose was to dynamically assess performance across conditions and not to intervene, establishing baselines was unnecessary. The three teaching conditions included (a) embedded action requesting during play, (b) embedded action labeling during play and (c) DTT action labeling with video models. During the control condition, participants were asked to identify verb symbols, but no direct teaching was provided.

Each participant was assigned five different verbs per condition. The use of different verbs was implemented to prevent carryover between conditions. Each child received four sessions per condition, and the condition order was counter-balanced so that each condition was not presented twice in one day. Assessment occurred twice a week with two to three conditions implemented each day. There were 16 total sessions (i.e., four per condition) for each child. The sessions were initially intended to be completed across six to eight days for

three to four weeks. Due to participant absences (primarily related to COVID-19 restrictions), participants completed the study over four to six weeks. For some participants, this led to longer gaps between dynamic assessment sessions.

**Assessment and Screening Measures**

The Childhood Autism Rating Scale Second Edition (CARS-2; Schopler et al., 2010) was used to confirm independent ASD diagnoses and provide estimates of autism severity. Severity classifications of the CARS-2 (e.g., mild-to-moderate, severe) correlate with other measures (Reszka et al., 2013). The third edition of the Vineland Adaptive Behavior Scales (VABS; Sparrow et al., 2016) was used to confirm parent reports of expressive communication delays. The VABS has indicators of validity and strong internal consistency (Pepperdine & McCrimmon, 2017).

Parents were interviewed to obtain additional information about the child's communication modalities, communication contexts, and preferences. The interview included a section where parents were presented with a list of 45 action words and asked to indicate which words, they believed their child would show interest in either requesting or labeling. Most of the words on the list were selected from the MacArthur-Bates Communicative Development Inventories (CDI; Fenson et al., 2006). The master's student and thesis advisor selected action verbs from the CDI that could be easily represented in play or video models or viewed as likely serve a request-based function in play contexts. Some action words not listed in the CDI that may be of particular interest for different sensory needs (e.g., squeeze, spin) were also included. Other words were also added based on parent recommendations regarding preferences. The researchers conducted semi-structured preference assessments to confirm parent reports of preference for actions, items, and activities. The steps for

completing the preference assessment are described in the procedures section. Finally, the researchers created protocols to assess participants' abilities to (a) identify graphic symbols representing targeted verbs and (b) follow a model or gesture prompt to make simple requests on an AAC application. These protocols are described in procedures.

**Independent and Dependent Variables**

The independent variable in this study was the different instructional contexts for presenting verb targets. The teaching conditions included embedded instruction for requesting actions during play, embedded instruction for labeling actions modeled during play, and DTT for labeling actions presented with video models. The control condition involved asking participants to identify verb symbols without any instructional support. All three conditions included the use of *what* questions, time delay, and a prompt hierarchy. These three conditions were differentiated by the communication opportunities, stimuli presented, and forms of reinforcement. A support score for each communication opportunity presented during a session was assigned based upon the level of support (i.e., prompt level) a participant needed to activate the speech output for the appropriate verb symbol. The dependent variable was the average DA support score per condition.

For the instructional conditions, support scores were as follows 5 = time delay; 4 = spoken prompt and general gesture; 3 = aided + spoken model; 2 = specific gestural prompt; 1 = physical prompt, and 0 = no correct independent or prompted response. Definitions of each of these support levels are provided in Table 2. The support score hierarchy was adapted from prior graduated DA research (Patterson et al., 2013; Binger et al., 2017b; Gevarter et al., 2020; King et al., 2015). The specific gesture was considered to provide more support than the model as it provided a more permanent cue to use the symbol (Gevarter et al., 2020). In

the three instructional conditions, a support score of zero was assigned in instances where a participant showed resistance to a physical prompt (e.g., reaching arm away) or continued to reject a communication temptation (e.g., child pushing away materials or walking away from materials on more than two attempts to introduce the temptation). For the control condition, as the prompting hierarchy was not utilized, participants could only receive a support score of 5 or 0. Average support scores across both the three instructional conditions and control were calculated for each session within a condition.

**Table 2**

*Support Score Definitions*

| Score | Support level | Definition |
|---|---|---|
| 5 | Time delay | Child made correct response within 6 s of opportunity |
| 4 | General gesture + spoken prompt | Child made correct response after researcher verbally reminded the child to use iPad and gestured in the direction of the iPad as reminder to use iPad |
| 3 | Aided model + spoken model | Child made correct response after clinician modeled correct symbol selection on iPad and provided a spoken model |
| 2 | Specific gestural prompt | Child made correct response after the researcher pointed to the correct symbol |
| 1 | Physical prompt | Child made correct response after the researcher guided the child's hand to press correct symbol |
| 0 | Unable to prompt (instructional condition) or no correct response made (control condition) | No correct independent or prompted response |

**Materials**

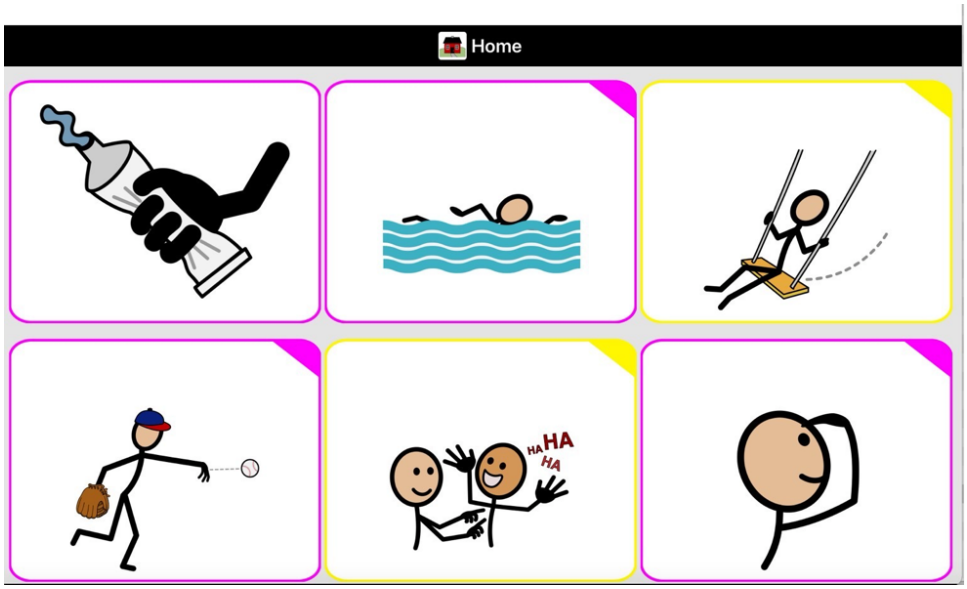
Materials for this study included preferred items/activities, video models of figurines completing actions, an iPad with the Proloquo2Go application (by Assistiveware), and paper printouts of verb symbols used for a symbol identification task. Parent report and preference assessment were used to determine preferred items for an AAC item requesting pre-assessment and the play/activity stimuli used to create communication opportunities in the embedded action request and embedded action label conditions. Parent report was also used to select preferred YouTube videos used to reinforce responses in the DTT video labeling condition. Videos included short clips from popular children's cartoons such as Veggie Tales, or Disney's Finding Nemo.

Video stimuli that depict targeted action words used the Toy Story figurines such as Woody, Buzz, Jessie, Bullseye, and Rex. Video stimuli were represented against a white background. Figurines presented in the videos were not specifically selected according to participants' interests, as DTT studies often do not embed participants' interests into the antecedent stimuli but rather use preferred items or activities as reinforcement (Marya et al., 2021). An additional laptop was used to play preferred YouTube videos as reinforcement for responses.

In the Proloquo2Go application, the researcher created four display pages for each child (i.e., one page per condition). Six picture symbols were presented per page, using a 2x3 array, and each symbol was 2.5 x 1 inch in size. The display included the five targeted verbs for that condition along with one distractor symbol. The Symbol Stix symbol library in Proloquo2Go was used to select picture icons for each targeted verb. The symbols included only the graphic picture and not written word labels (refer to Figure 1 as an example).

**Figure 1**

*An Example of a Proloquo2Go Display Page*




For the play and request conditions, targeted verbs were assigned based on (a) parent's suggestions regarding preferred actions for requesting or labeling during play (e.g., parent noted a child likes to blow bubbles) (b) how verbs could be grouped together during different play contexts (e.g., pour, splash, swim, for a water table activity), (c) observations of how children interacted with stimuli during informal preference assessments. For the video and control conditions, we selected verbs that parents suggested their children would be interested in but were not assigned to the play or request condition. Screenshots of Proloquo2Go display pages were made into paper printouts containing the targeted verb symbols for each child. The printouts were used to assess receptive identification of verb symbols during the pre-assessment phase.

## Procedures

### *Parent Interviews and Preference Assessment*

Before beginning DA sessions, the researchers completed formal and informal assessments with parents and conducted preference assessments. Specifically, parent interviews using the CARS-2 (Schopler et al., 2010), and the expressive and receptive sections of the VABS (Sparrow et al., 2016) were used to respectively provide estimates of ASD severity and communication skills. Using a researcher created interview, parents also provided suggestions regarding their child's preferred items, activities, videos, and actions. Direct preference assessments were then implemented using materials and actions suggested by parents. First, a multiple stimulus without replacement preference assessment (DeLeon & Iwata, 1996) was used to determine snack or toy items to incorporate during the AAC item requesting assessment used for screening purposes. The top five ranked items were selected for the item requesting screening assessment. To select preferred items for the DA conditions the researcher used variations of a single stimulus preference assessment (Pace et al., 1985). For the embedded action label condition, the researcher presented the learner with parent-recommended preferred toys that could be used to model target actions (e.g., using a sensory toy to model the action SQUEEZE). The researcher recorded whether the learner engaged with the toy (e.g., picked it up, played with it) and attended to actions modeled with the toy. To determine preferred items to be used for the embedded action request condition, the researcher attempted to engage the learner in a parent-suggested preferred action (e.g., bouncing the child on a ball) and recorded whether the child engaged in the action. Finally, to determine preferred videos that would be used as reinforcers in the video condition, the researcher played YouTube video clips suggested by parents (e.g., Finding Nemo) and noted

whether the child watched the video and showed other signs of interest (e.g., smiling laughing).

### *AAC Item Requesting Screening Assessment*

During this screening task, participants were presented with a Proloquo2Go application display with symbols representing five preferred snack or toy items selected via preference assessment. The researcher created 20 opportunities for the child to request the preferred items by intermittently offering the child all five items, observing which item the child reached or pointed to, holding up that item at the start of a trial, and presenting the child with the AAC display. The researcher then implemented a least-to-most prompting hierarchy involving a 6 s time delay, general gesture+ spoken reminder to use device, aided model + spoken model, specific gesture, and physical prompt. The first 5 of the 20 total trials were considered practice trials and were not counted for screening purposes. Participants who needed no more than a gesture prompt for at least 10 of the 15 assessment trials (66%) met the study criteria. This criterion is based on the study by Gevarter et al. (2020), in which participants who showed progress with non-noun-based symbols rarely required more than a gesture prompt in an item-requesting condition.

In contrast, participants who frequently required physical prompts for item requests did not show progress with non-noun symbols (Gevarter et al., 2020). As mentioned previously, one potential participant was excluded from this study based on this screening. He required physical prompts for all trials. Average support scores across the final 15 trials of this assessment for participants who met criteria were as follows: 4.5 for Elijah and Pedro (i.e., relatively few prompts), 3.3 for Nate (i.e., mostly requiring a model), and 2.5 for Sean (i.e., mostly requiring model or specific gesture prompts).

***Verb Symbol Identification Pre-Assessment***

For the verb symbol identification pre-assessment task, participants were presented with paper printouts of Proloquo2Go displays with the verb symbols that had been initially assigned to each condition. The researcher verbally directed the child to *show me (verb)* and wait 6s before marking whether the child pointed to or touched the correct symbol. To reinforce the completion of the task, participants were intermittently provided with small amounts of preferred snack or toy items regardless of whether responses are right or wrong. Three trials were conducted for each potential verb target across multiple sessions. If a child receptively identified a symbol across all three trials, this verb was not included during dynamic assessment for that child. Pedro was the only child who identified any of the selected verbs. Initially, he correctly identified nine of his selected verbs (38%). Additional receptive testing and preference assessments were conducted until a sufficient number of unknown verbs were identified.

***Dynamic Assessment***

Each session for each condition consisted of 10 communication opportunities to use targeted verbs (i.e., two opportunities with each verb for that condition). After an opportunity was initiated, the iPad display with targeted verbs was placed in front of the child for all conditions. The researcher used a time delay of 6s to wait for the child to make a response. In the three instructional conditions, incorrect responses (e.g., making no response, using a non-targeted verb symbol, pressing other iPad parts that did not produce output) were corrected using a least-to-most prompt hierarchy. The hierarchy included, in order from least to most: (1) a spoken reminder + general gesture, (2) aided model + spoken prompt, (3) a specific gestural prompt, and (4) a physical prompt. These prompts corresponded to the support

scores described in Table 2. The spoken reminder + general gesture to use the device was skipped if an incorrect response included touching the iPad. If a child resisted a physical prompt (e.g., pulling hand away, body language, or escape behaviors), they were not forced to select a symbol. Independent or prompted responses resulted in reinforcement specific to a condition (described below). For all conditions, if a child was not attending to the stimuli at the start of a trial, the opportunity was repeated once before moving to the prompt hierarchy. The researcher could also slightly vary materials to try to engage the child in the temptation. If, however, a child showed continued signs of rejection (e.g., pushing away items or walking away without interacting with the iPad), the trial was discontinued. Procedures for each condition are described below, and Table 3 provides a summary of the unique components of each condition.

**Embedded Action Requesting During Play**. During this condition, to create a communication opportunity, the researcher first allowed the child to engage in the target action for a short period of time (e.g., jumping on trampoline) or modeled a desired action the child would need the adult's assistance to complete (e.g., opening a container with preferred toys). Then the researcher interrupted or stopped the activity (e.g., stopped the child from jumping, or closed box with preferred items), asked the child what do you want to do? /what should we do? and presented the iPad. The prompt hierarchy described above was utilized. Reinforcement was provided for correct independent and prompted responses and consisted of continuing the desired action. The researcher also provided a grammatically complete verbal expansion (e.g., Oh, you want to jump). If the child did not show interest in the request opportunity presented, the researcher could either attempt to repeat the opportunity or stop the trial and try to re-introduce that action at a later point during the

session. The researcher could also vary materials to try to increase motivation for requesting (e.g., place other preferred items inside the box to increase motivation for OPEN).

**Embedded Action Labeling During Play.** In this condition, communication opportunities were embedded in a play context. The researcher allowed the child to engage freely with play items and intermittently looked for opportunities to model targeted actions themselves (e.g., clinician dropped a ball) or with figurines (e.g., clinician showed a dinosaur biting). If the child did not attend to the stimuli, the researcher directed the child's attention by saying *LOOK* and repeating the model and question one more time. Again, materials could also be varied slightly to increase attendance (e.g., using a different dinosaur to model biting). After modeling the action, the researcher asked, *What did __ do?* or *What happened*? while presenting the iPad, and then using the prompt hierarchy as needed. Reinforcement was provided for correct independent and prompted responses. In this case, reinforcement involved allowing the child to continue playing with toys freely (with the researcher joining in play as appropriate). A verbal expansion (e.g., *The dinosaur is biting*) was also provided.

**DTT Action Labeling with Video Models.** To create a communication opportunity in this condition, the researcher played a short video clip showing the target action. After the video ended, the researcher asked, *What did_____do* or *What happened?* while *presenting* the iPad display, and used the prompt hierarchy as needed. If the child was not attending to the stimuli, the researcher directed the child's attention by saying *LOOK*. Reinforcement was provided for correct independent and prompted responses and consisted of playing a preferred YouTube video for 30 seconds. A verbal expansion (e.g., *Woody is jumping*) was also used. Additional reinforcement in the form of small sensory toys were added for Nate who sometimes had difficulty transitioning to or maintaining interest in the video condition.

**Control**. To create a communication opportunity in this condition, the researcher presented the Proloquo2go display and said Show me (verb). The researcher then waited 6s for a response but did not provide any prompts. Intermittent reinforcement using preferred toys or snack items, or positive verbal feedback (Great job, pointing) was provided for participating in the task, but was not contingent upon correct responding.

**Table 3**

*Description of Conditions*

| Condition | Communication opportunity | Question | Time delay and prompting | Reinforcement |
|---|---|---|---|---|
| Action requesting during play | Engage the child in the target action, then interrupt or stop the action | "What should we do? "or "What do you want to do?" | Wait at least 6 s for response and use prompting hierarchy | Carry out the requested action and expand the utterance |
| Embedded action labeling during play | During play, intermittently use toys to perform a target action | "What did ___ do?" or "What happened?" | Wait at least 6 s for response and use prompting hierarchy | Allow child to continue playing with preferred toys and expand the utterance |
| DTT action labeling during play | Play a video model of target action | "What did ___ do?" or "What happened?" | Wait at least 6 s for response and use prompting hierarchy | Play a preferred YouTube video for 30 seconds and expand the utterance |
| Control | Ask child to choose the correct symbol | "Show me ____?" | Wait at least 6 s for response and no prompting used | No reinforcement provided for correct or incorrect responses. |

### *Treatment Fidelity*

All sessions were videorecorded. The thesis student and advisor created a task analysis of steps to complete a trial. These steps included the following: (a) present

appropriate communication opportunity for condition, (b) present correct display, (c) use time delay (waiting 6s for a response), (d) implement prompt hierarchy correctly, (e) reinforce prompted or independent responses, and (f) use a verbal expansion. For fidelity checks, at least one session in each condition per participant, plus two additional sessions from any condition (i.e., 38% of all sessions) were randomly selected for fidelity checks. The thesis student and advisor served as coders and independently conducted fidelity checks for sessions in which they were not the interventionist. Coders marked whether each step was completed correctly for each trial in a session. Fidelity scores were calculated for each participant by dividing the number of steps followed correctly by the total number of steps multiplied by 100 (Schlosser, 2002). Scores were 97% (range 93%-100%) for Nate, 99% (range 98%-100%) for Pedro, 96% (range 88%-100%) for Sean, and 100% for Elijah.

***Data Coding and Analysis***

The thesis student and advisor independently coded videos and recorded support scores. For each trial in a teaching condition session, the coder marked the level of support (1-5) a participant needed to select the targeted verb symbol or scored a zero when no correct independent or prompted response was made. For the control condition, dichotomous scores of either 0 (symbol not correctly identified) or 5 (symbol correctly identified) were assigned. Average support scores for each session were calculated and graphed across sessions. A visual analysis method (Kratochwill et al., 2012) was used to compare differences in level, trend, and variability between conditions. In addition, the mean level of responding in each condition was computed within and across participants.

### *Inter-Observer Agreement*

The thesis student and advisor independently conducted inter-observer agreement (IOA) checks for participants for which they were not the primary coders. The same sessions used for treatment fidelity checks were also used for IOA (i.e., 38% of sessions with at least one per condition). Observers coded the level of support for each trial in a session for each participant. Trial-by-trial IOA was calculated by dividing the number of agreements by the sum of the agreements and disagreements and multiplying by 100. Average IOA scores were as follows 85% (80-100%) for Elijah, 97% for Nate (93-100%), 99% for Pedro (98-100%) and 96% for Samuel (88-100%), indicating that the data were reliably coded.

## Results

Results are described according to each research question. Table 4 provides the average support scores across the four participants for each condition. Individual participant data are in Figures 2 through 5.

**Table 4**

*Average DA Support Scores Across Participants and Conditions*

| | Request | DTT Video Label | Play Label | Control |
|---|---|---|---|---|
| Elijah | *M*=3.38<br>*SD*=1.10 | *M*=2.98<br>*SD*=1.20 | *M*=2.80<br>*SD*=1.18 | *M*=0.50<br>*SD*=1.52 |
| Nate | *M*=2.85<br>*SD*=0.98 | *M*=2.33<br>*SD*=1.35 | *M*=1.87<br>*SD*=1.42 | *M*=0.10<br>*SD*=0.79 |
| Pedro | *M*=3.60<br>*SD*=1.35 | *M*=3.38<br>*SD*=1.08 | *M*=2.9<br>*SD*=1.28 | *M*=3.62<br>*SD*=2.26 |
| Sean | *M*=3.45<br>*SD*=1.01 | *M*=3.05<br>*SD*=1.06 | *M*=3.23<br>*SD*=1.19 | *M*=0.38<br>*SD*=1.33 |

**Figure 2**

*Elijah's Average DA Support Scores Across Session and Conditions*

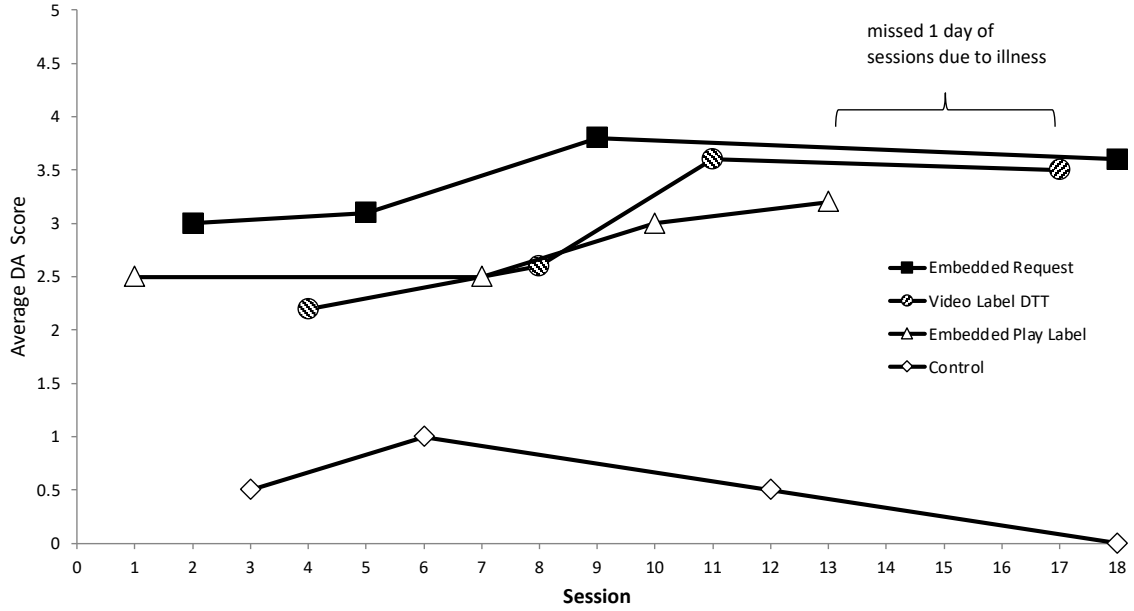



**Figure 3**

*Nate's Average DA Support Scores Across Session and Conditions*

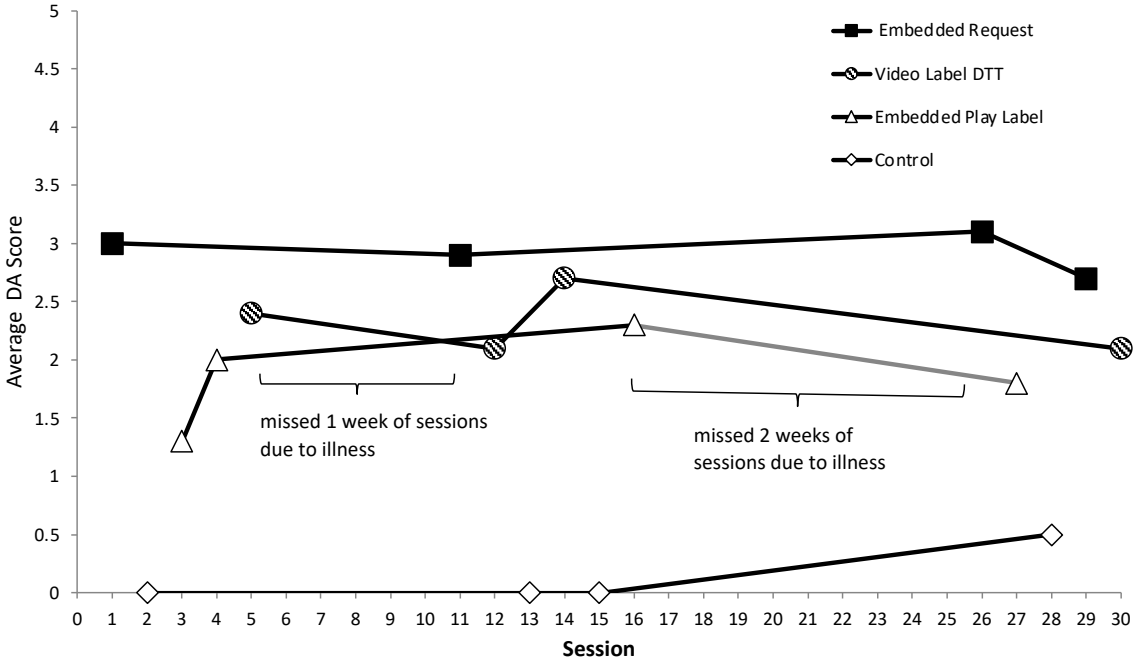


**Figure 4**

*Pedro's Average DA Support Scores Across Session and Conditions*

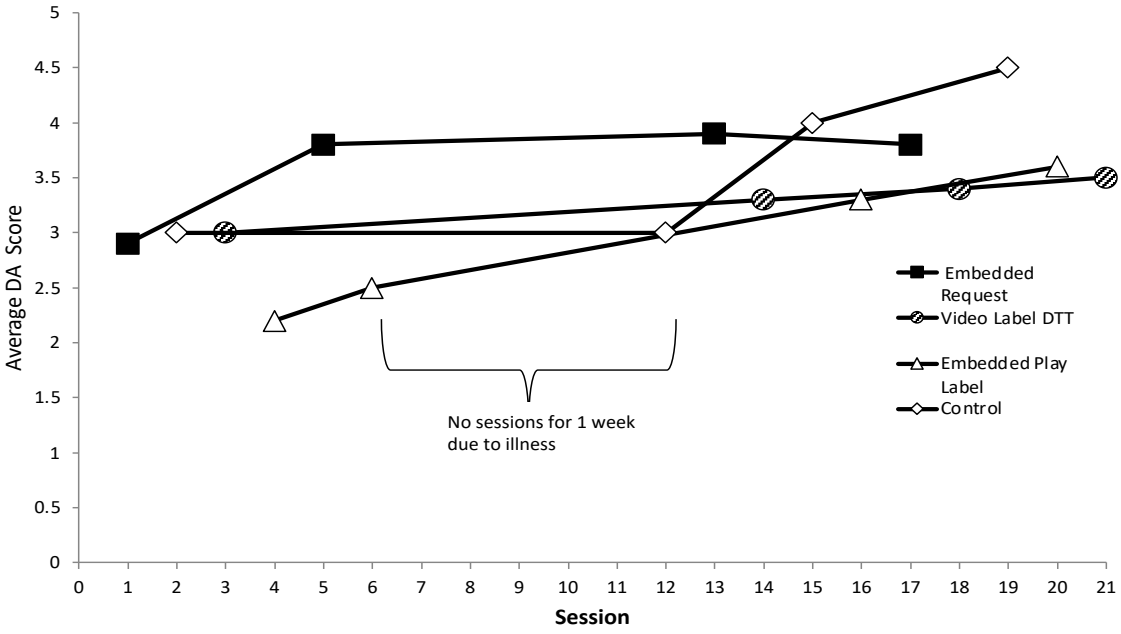
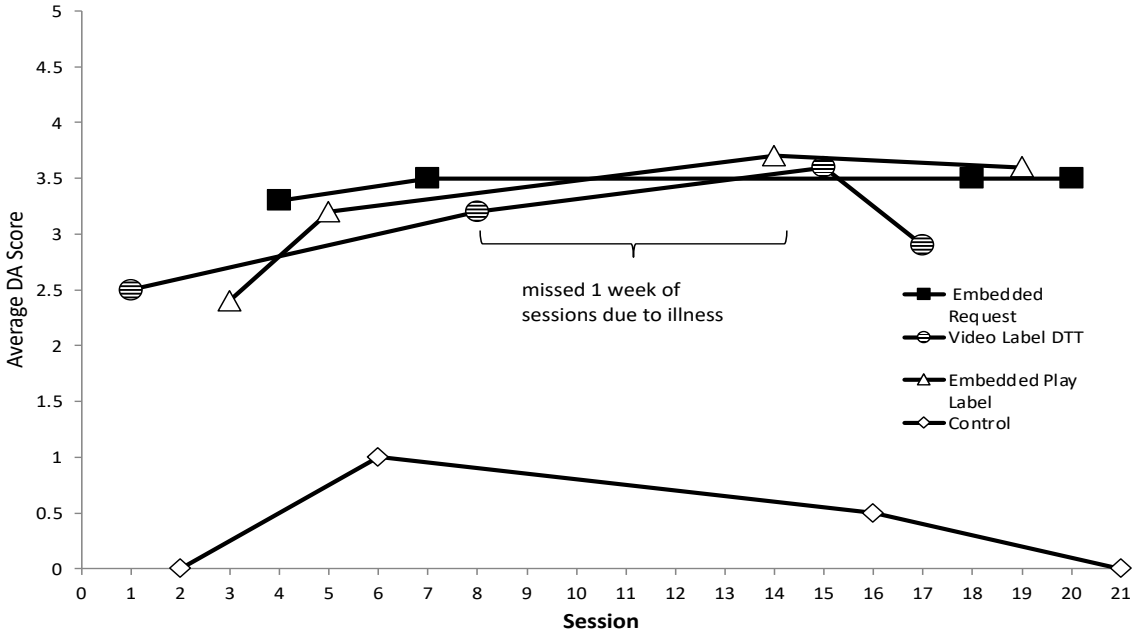



**Figure 5**

*Sean's Average DA Support Scores Across Session and Conditions*



**Research Question 1: Progress in Learning to Use Verb Symbols**

Experimental control between instructional conditions and the control condition was established for three of the four participants (Elijah, Sean, Nate). Three participants (Elijah, Pedro, and Sean) also demonstrated evidence of learning by increasing average support scores (i.e., reducing their levels of support needed) in at least two instructional conditions. Elijah and Sean did not increase their level of independence with responding in the control condition, and there was no overlap between the instructional conditions and control. Pedro did, however, demonstrate an increase in independent responding in the control condition and had overlap in support scores with all instructional conditions and control. Of note, Pedro was the only participant who could receptively identify verb symbols during pre-assessment (correctly identifying 38% of symbols probed). Although DA only included targets he could did not receptively identify during pre-assessment, the control condition was similar in nature to the receptive pre-assessment. The fourth participant, Nate, did not demonstrate increases in support scores in any instructional conditions, or in the control condition, but did respond with low support levels (e.g., models or gestures) in some conditions. He also did not show any overlap between scores for instructional contexts and the control condition. Across participants, modeling (Level 3) was the most common prompt level required for correct responding. Participants infrequently required a general reminder to use the iPad (Level 4) as incorrect responses typically involved interacting with the iPad but selecting the wrong symbol.

**Research Question 2: Differences in Learning Based on Pragmatic Function**

Teaching verbs using a requesting format appeared to have some initial advantages for participants. During their first requesting sessions, three participants (Elijah, Nate, and

Sean) required less support than they did with either of their first labeling conditions. These three participants responded to most initial request trials with no more than a model prompt (Level 3). In comparison, Elijah and Nate more frequently required specific gesture cues (Level 2), and occasionally needed physical prompts (Level 1) to use verb symbols in initial labeling sessions. Nate often required specific gestures (Level 2) or physical prompts (Level 1) and occasionally could not be prompted (Level 0) in labeling conditions. Pedro's support score for his first requesting session was similar to his first video labeling session (primarily responding to specific gestures, models, or a time delay alone), but on his first embedded play labeling session he required some physical prompting (Level 1) and did not respond to some prompts (Level 0). By his second session with each condition, Pedro began to show modest differentiation between requesting and labeling as he increased his responding after the time delay alone (Level 5) in the requesting condition.

Participants maintained consistency of responding with low support levels (i.e., with most trials at a Level 3 or above) in the requesting condition. Four participants also had higher mean support scores (i.e., required lower support levels) in the requesting condition than either the DTT video label or embedded play label conditions (see Table 4). Over time, although Elijah and Pedro demonstrated modest gradual increasing trends with requesting (e.g., starting to respond to some trials after the time delay alone while maintaining other responses at a modeled level), increases in one or more labeling conditions led to overlap between labeling sessions and some requesting sessions. Although Sean maintained his ability to respond to low levels of support in the requesting condition, he did not show clear increases in trend in this condition but did show progress in labeling conditions. Because of this, Sean showed less differentiation between requesting and labeling. In comparison to

other participants, Nate showed the most consistent differentiation between requesting and labeling conditions as he continued to require low levels of support (primarily Level 3 modeling) for requesting, but for labeling conditions he still needed specific gestures (Level 2), or physical prompts (Level 1) throughout DA sessions. His data indicated minimal overlap between requesting and the video label condition and no overlap between requesting and play labeling.

**Research Question 3: Differences Between Embedded Play and DTT Video Labeling**

Findings indicate minimal difference between embedded instruction in play and DTT with videos for labeling. Although three of the four participants (Elijah, Nathan, and Pedro) had higher mean scores in the video condition compared to play, there was consistent overlap between the two conditions (with Nate having slightly less overlap). Sean also had overlap between conditions but had a slightly higher mean score in the play condition compared to video. In terms of trend, Elijah had a slightly steeper increasing trend in the DTT video condition but also showed growth in the play condition. Sean and Pedro showed slightly steeper increases in trend in the play condition compared to DTT video, and Nate did not increase scores in either condition. By the end of the assessment, Elijah and Pedro infrequently needed supports greater than a model (Level 3) in either labeling condition and responded after the time delay alone (Level 5) in some instances across both labeling conditions. Sean primarily responded to models (Level 3) or a time delay alone (Level 5) in latter sessions in the play condition but did still require some specific gestures (Level 2) in last session of the video DTT condition. Nate still frequently required specific gestures (Level 2) and physical prompting (Level 1) in latter labeling sessions. Across sessions, he

required more physical prompts (Level 1) in the play condition than he did in the video condition.

## Discussion

In this study, three of four participants showed modest reductions in the levels of support they needed to use verb symbols in at least two teaching conditions during a graduated prompting dynamic assessment (DA). Participants also demonstrated some individualized differences in performance across conditions. Experimental control showing differences between instructional conditions and the control condition was established for three of the four participants. Although there were some initial modest advantages of the requesting condition, clear experimental differences between this condition and labeling conditions was only demonstrated for one participant. The discussion that follows highlights clinically relevant findings and provides recommendations for future research based on study limitations.

### Verb Learning Potential

Results of this study support prior research demonstrating mixed outcomes when teaching children with ASD to use verb symbols (Carnett et al., 2019; Gevarter et al., 2021, 2022; Holyfield, 2021). Three participants with mild-to-moderate ASD characteristics (Elijah, Sean, Pedro) showed evidence of learning to use verb symbols with reduced levels of support in at least two teaching conditions. One of these participants (Pedro) also learned verb symbols in the control condition. The fourth participant (Nate), who had severe characteristics of ASD, did not demonstrate growth in any condition during DA. These findings are similar to those of Gevarter et al. (2020), in which three participants with mild-to-moderate ASD showed more progress in learning to use noun and non-noun symbols to

request actions and make comments than three participants with severe ASD. However, it is important to note that despite showing limited signs of growth, Nate was able to respond to low level prompts (i.e., models) in the requesting condition from the start of DA. He might, therefore, still be likely to show progress in acquiring verb targets for requesting during intervention given more practice opportunities.

The results of the current study also differ from Gevarter et al. (2020), in that prior PECS experience did not appear to impact success. Although two participants (Sean, Pedro) who showed progress with verb targets did not have prior PECS experience, Nate (who did not show growth) was a PECS user. Clinicians should consider the characteristics of a learner when introducing new AAC targets but the current study does not suggest that prior experience with low-tech aided AAC is a prerequisite for introducing high-tech systems. Additionally, findings do not suggest specific prerequisites for teaching verb targets.

This study does suggest, however, that some children with ASD may require more support to acquire independent use of verb symbols on high-tech AAC systems. For instance, although most participants decreased support levels and produced independent responses in more than one condition, none of the participants independently initiated the use of verb symbols for a majority of responses in any condition. In comparison, children with mild-to-moderate ASD in the Gevarter et al. (2020) showed consistent independent responding using noun symbols to request items and showed greater improvement with non-noun symbols (including verbs) than participants in the current study. Although intervention research suggests that that acquisition of non-noun symbols may be more gradual than noun symbols (Gevarter et al., 2021, 2022, Holyfield, 2021), it is possible that introducing different parts of speech simultaneously could lead to greater improvements across symbol types. In this study,

we only assessed noun use during a pre-assessment item requesting DA task. Supporting the findings of Gevarter et al. (2020), most participants had higher DA scores (i.e., required less support) with item requesting during the pre-assessment than during initial DA sessions with verbs. Given these findings, clinicians should consider introducing symbols representing different parts of speech during DA to determine if this supports symbol learning. Such an approach would align with recommendations derived from typical language development theories.

Although gradual progress with verb symbols may be expected, less rapid improvements in this study may also have been impacted by the limited opportunities to practice specific targets. For instance, in this study, participants only had two trials with each verb target per session, but in the Gevarter et al. (2020) study participants had four trials per target. Prior research suggests that increasing dosage or the number of teaching trials may improve children's responses to AAC intervention (Logan et al., 2017). Delays may have negatively impacted improvement with verb symbols in between sessions; three participants had at least one week where they missed DA sessions due to COVID-19 restrictions. Notably, the participant who did not demonstrate growth also had the lengthiest breaks between sessions. To better understand participants' learning potential with verb symbols, clinicians could consider conducting fewer DA sessions that include more trials with specific targets.

It is also possible that learning to use verb symbols expressively could be impacted by receptive knowledge. Some prior studies that have included verb interventions for children with ASD have excluded children who could not receptively identify targeted actions (Frampton et al. 2016; Mayra et al., 2021). In this study, to control for differences in symbol knowledge across conditions we only targeted verbs that participants could not receptively

identify. Only Pedro receptively identified verbs symbols during pre-assessment (initially identifying 38% of potential targets). Although the verbs he identified were not used in any of the DA conditions, he was the only participant who showed independent responding in the control condition, which was similar in nature to the receptive pre-assessment. Interestingly, Pedro's receptive skills did not immediately generalize to the expressive teaching conditions. Thus, although clinicians may want to assess a child's receptive knowledge of verb symbols prior to DA or intervention, it should not be assumed that receptive knowledge will predict expressive use.

Although not formally assessed, anecdotal evidence from this study also suggests that clinicians should consider how symbol characteristics may affect verb learning. Across conditions, some of the symbols that participants were most likely to use independently appeared to be more iconic. For example, symbols representing the actions blow and jump included relevant objects within the graphic representation of the actions (e.g., the BLOW symbol included a balloon, and the JUMP symbol included a trampoline) that may have made the symbols more transparent, compared with symbols such as G.O. (which was represented by a green arrow). Starting with verb symbols that are more iconic may be beneficial. Clinicians should consider assessing a variety of symbol sets to determine which sets are most transparent for a given learner. As they become more readily available, clinicians could also include animated verb symbols in symbol assessment.

Some participants also showed preferences for specific AAC symbols depending on speech output, appearance, or location. For example, Pedro chose RIDE consistently in the DTT video condition and appeared to enjoy the speech output of the symbol (e.g., would press it repetitively while smiling). Sean also frequently activated the SWIM symbol in the

play condition, which could have been impacted by the fact that the symbol may have been associated with the larger water play routine. Nate showed a location preference as incorrect responses often involved him choosing symbols located in the top center of the AAC display. Clinicians should consider collecting data on symbol appearance, speech output, or location preferences and make modifications to instruction or displays as needed.

**Differences Between Pragmatic Functions**

Although three of the four participants showed progress in more than one instructional condition, there appeared to be some initial advantages of the requesting condition. Specifically, three participants required lower levels of support in their first requesting DA sessions than they did in either of their first labeling sessions. All four participants also had higher mean DA scores (i.e., required the lowest levels of support) in the requesting condition than in either of the labeling conditions. Across participants, a majority of request trials occurred following a model prompt (Level 3) or after a time delay alone (Level 5). Pedro also had higher rates of responding to the time delay alone in the requesting condition than in either of his labeling conditions. Specific gesture prompts (Level 2) and physical prompts (Level 1) were utilized more frequently in early labeling sessions for Sean, Elijah, and Nate, and Nate continued to require these higher support levels throughout labeling sessions. These findings support prior research suggesting that children with ASD may be more likely to use imperative communicative functions than declarative functions (Jones et al., 2009; La Valle et al., 2020). Although DA might be useful for determining what communicative targets can be introduced first using the least restrictive prompts, it can also demonstrate a reduction in supports needed over time for other targets.

Although beginning verb symbol instruction with imperative language functions may have advantages for some children with ASD, individual differences in social communication skills (e.g., joint attention) and motivation may differentially impact growth with both imperative and declarative functions. For instance, the fact that Nate maintained the most clear-cut differences between requesting and labeling conditions was likely influenced by the fact that he was the only participant who showed consistent difficulty attending to stimuli in the labeling conditions. These findings support prior research suggesting that children with limited joint attention skills may experience more difficulties using declarative language functions (La Valle et al., 2020).

Clinicians may, therefore, want to consider beginning verb symbol instruction with motivational requesting activities for children with limited joint attention skills prior to transitioning to other functions. This approach may not, however, be necessary for all children with ASD, as other participants in this study appeared to be motivated by and interested in their labeling activities. For example, during the video condition, Elijah would laugh at specific videos and try to re-play them. At the start of a DA session, Sean would also seek out materials used for his water play labeling activity. However, due to high interest in chosen stimuli, some labeling targets may have on occasion served a request function. For example, after the researcher poured water during the play condition and Sean labeled POUR, he would sometimes take the clinician's hand and guide it back to water jug to show that he wanted to pour more. In such cases, clinicians should assess whether targets that appear to serve a partial request function can be generalized appropriately to other pragmatic contexts (e.g., can the child label the action represented in a picture storybook).

Although some participants appeared to show more motivation to participate in labeling conditions over time, in other instances, motivation to request certain actions varied over time. For instance, Elijah showed decreased interest in requesting using a symbol for PUT IN. Although the clinician made efforts to increase motivation by using different stimuli (e.g., putting small figures in a truck, or putting mini cars inside a bucket) this did not always increase interest. Pedro also initially showed more limited motivation to request some actions, which may have been due to the fact that some of his highly preferred actions could not be targeted because he receptively identified them during the pre-assessment phase. Varying the stimuli used to request actions such as OPEN (e.g., using boxes or bags with different preferred items inside) did appear to increase Pedro's motivation to request over time. Although practitioners should use preference assessments to select highly preferred stimuli that can be used for requesting actions, they should also consider using varied toys and activities to maintain interest in requesting. In clinical contexts, practitioners can also change targets used across sessions based on the child's specific interests on a given day.

**Differences Between Teaching Contexts for Labeling**

Although there were some differences between requesting and labeling conditions, there were fewer differences between the two labeling conditions comparing embedded instruction with live models during play to DTT with video models. Across participants, there was consistent overlap between conditions. Although Elijah, Pedro, and Sean showed growth across both labeling conditions, Pedro and Sean showed slightly more growth in play conditions. When there are minimal acquisition differences between embedded and DTT approaches, other potential advantages of an embedded approach such as fewer challenging behaviors, improved affect, or increased generalization to natural contexts should be

considered (Sigafoos et al., 2006). Although Nate did more frequently require physical prompting in the play condition than he did with the video DTT task, he did not make clear progress with either condition. After Nate showed escape behaviors (walking away from the stimuli) with the video DTT condition, the use of tangible reinforcers (e.g., small sensory toys) was added to condition so that he would engage in the task. Although Nate did not show escape behaviors during play (where he was able to interact with a variety of preferred stimuli) he often appeared to have difficulty shifting his attention towards the toy stimuli the interventionist was using to model actions. Thus, although it may be suggested that children with limited joint attention skills can benefit from a video model approach with fewer distractions (Charlop-Christy et al., 2000; Plavnick et al., 2016), motivation to attend to video tasks must also be considered. To improve engagement with labeling actions, clinicians should select preferred stimuli that could be used in either video or play contexts. For learners with more limited joint attention skills, the use of external reinforcers might need to be considered but should be faded so that learners respond to natural forms of reinforcement alone.

**Limitations and Directions for Future Research**

Although one of the limitations of this study is that DA did not reveal consistent verb learning differences between instructional conditions, findings did provide some insight into how personal characteristics, symbol features, prompt levels, and motivational factors might impact verb learning. However, the design of this study prevents explicit claims regarding the utility of DA for differentiating the importance of these variables or predicting intervention success. Future research should focus on determining what factors (e.g., characteristics of ASD) impact verb learning differences during DA and intervention. For instance, formal

assessments of joint attention skills could be used to compare groups of children with mild ASD characteristics and strong joint attention to those with more severe characteristics and limited joint attention. Additionally, follow-up intervention studies can be used to evaluate whether DA predicts intervention success.

Other study limitations may have also contributed to the fact that participants demonstrated limited independence in using verb symbols. First, in this study, although the intended timeframe for DA was 2 -3 weeks, most participants had COVID-19 related absences that led to an extended assessment period that may not have supported skill acquisition. Telehealth approaches for supporting DA could be considered. Additionally, as participants may not have had enough practice with specific verb targets to demonstrate evidence of learning during DA, future studies should include more trials or focus on fewer targets at a time. Furthermore, as the researchers did not control symbol transparency, future research should explore how the use of iconic versus non-iconic symbols affects verb learning. More research examining the benefits of animated symbols is also warranted (Schlosser et al., 2019). Finally, it could be useful to compare whether teaching verb targets alone versus teaching verbs and nouns simultaneously improves symbol learning.

Additional study limitations relate to how DA sessions were scored and implemented. First, even though a majority of participants did not show progress in the control condition (i.e., did not begin to respond independently without supports) it may be difficult to compare scores from the instructional conditions to the control due to differences in scoring. Because participants did not receive any support in the control condition, a learner could only earn a score of 0 (indicating an incorrect or no response) or a 5 (indicating an independent correct response) for any given trial. In contrast, the instructional conditions were scored on a scale

ranging from 0-5 to indicate the level of prompting needed for a correct response. Most participants' data showed differentiation between the control and instructional conditions because they were unable to respond correctly without the use of prompts. However, the fact that one participant (Pedro) did acquire targets in the control condition without any support may indicate that the use of prompts to support learning may not always be needed for familiar tasks, as Pedro was the only participant to demonstrate receptive symbol identification prior to DA. Future research could explore how children with prior receptive symbol knowledge generalize skills to both receptive and expressive AAC skills.

Finally, in this study, DA was conducted in one-on-one clinical environments by trained researchers. The use of the DA procedures was not tested by speech-language pathologists (SLPs) or other educators in natural contexts (e.g., schools, homes). Although an SLP graduate student learned to use techniques with fidelity without extensive training, replication across different implementers is needed. Researchers should seek input from practicing SLPs about feasibility or adaptations to DA procedures, and explore processes for training clinicians in the use of DA.

## Conclusion

DA with a graduated prompt hierarchy demonstrated that children with ASD (a) show learning potential with action verb targets across both requesting and labeling functions, (b) may, in some cases, show modest initial advantages of learning to use verbs to request, and (c) may not show large differences in their ability to learn to label action verbs across different instructional contexts. Although teaching the use of AAC verb symbols to children with ASD appears to be an appropriate intervention target, gradual progress may be expected, and clinicians should consider how the inclusion of motivating stimuli and contexts

influences progress. Additionally, although introducing verb targets in a requesting context may provide initial advantages, this study suggests that some children with ASD can simultaneously make progress in their use of verb symbols for labeling purposes. Given the developmental overlap between requesting and labeling, it is important to introduce both communicative functions. More research is needed to determine how factors such as ASD severity, joint attention skills, symbol iconicity, and motivational preferences impact the acquisition of verb symbols.

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